Abstracts of 2003 JMU REU Projects

Title. *Pretzel knots and colorability* (2003)

Students. Kathryn Brownell, Lenoir-Rhyne College
Kaitlyn O'Neil, Merrimack College

Mentor. Laura Taalman

Abstract. We develop a formula for determining the number of fundamentally different ways that an m-colorable knot can be m-colored, based on the m-nullity of the knot. We then determine the m-nullity of any (p,q,r) pretzel knot, and thus a way to determine the m-colorability and number of fundamentally different m-colorings of any pretzel knot.

Title. *k-alternating knots* (2003)

Students. Philip Hackney, Central Michigan University
Nathan Walters, Drake University

Mentor. Leonard Van Wyk

Abstract. A projection of a knot is *k-alternating* if its overcrossings and undercrossings alternate in groups of k as one reads around the projection (an obvious generalization of the notion of an alternating projection). More generally, a projection is *w-repeating* if, rather than alternating in groups of k, the crossings follow any pattern whatsoever. We show every knot that admits a k-alternating projection also admits a $(k+1)$-alternating projection, and that every knot that admits a w-repeating projection admits a k-alternating projection for $k \leq \frac{|w|}{2}$. We also prove the surprising result that every knot admits a 2-alternating projection, which partitions nontrivial knots into two classes: alternating and 2-alternating. Finally, we explore the notion of the *k-alternating excess* of a knot, the difference between the smallest number of crossings in a k-alternating projection of the knot and its crossing number.

Title. *Pade approximates for torsion of a compressible nonlinearly elastic cylinder: modeling, computation, and visualization* (2003)

Students. Danielle Miller, James Madison University
Jennifer Salyer, East Tennessee State University

Mentors. Debra Warne, Paul Warne

Abstract. The boundary-value problem (BVP) resulting from the equations of nonlinear elastostatics for torsion of a circular cylinder for a class of general Blatz-Ko materials involves a nonlinear, singular, 2^{nd} order ordinary differential equation for the radial deformation with non-standard boundary conditions. Using a new computational approach to project the BVP to a polynomial system, we are able to compute the MacLaurin coefficients of the solution to any degree and then accurately solve for the radial deformation by numerically creating its Pade approximation. Significant improvements in both accuracy and efficiency are shown for the new method compared with the standard Runge- Kutta algorithm. Animations are created to show 3-D visualizations of the torsional deformation of the cylinder.

Title. *Statistical methods for rough QTL analysis* (2003)

Students. Mark J. Giganti, University of Missouri
Nathan A. Johnson, College of William and Mary

Mentor. Steven Garren

Abstract. Most methods for the identification of quantitative trait loci (QTLs) employ a parametric approach which assumes the normality of the phenotype distribution. However, most applications of QTL analysis do not have normally distributed phenotypes. In this research, we compare different parametric and nonparametric approaches to both single marker and paired marker selection analysis. A simulation study is conducted to compare the prediction errors for each method.